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POWDERY MILDEW OF PEAS

By R. F. CRAWFORD

Dusting peas with a two-row cotton duster.

AGRICULTURAL EXPERIMENT STATION

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POWDERY MILDEW OF PEAS

INTRODUCTION.

Powdery mildew of peas causes heavy loss practically every year in the higher altitudes in New Mexico; especially to the late crop; it being the most serious obstacle to the successful production of the crop in the mountainous sections of the State. Owing to the seriousness of this disease, an experimental plot was established on the Storrie Project at Las Vegas, New Mexico. The land for the plot, water for irrigation, and seed were donated by the Las Vegas Land & Water Company. The New Mexico Agricultural Experiment Station furnished an assistant, who was kept at the plot during the entire season, attending to the planting, irrigation, cultivation, dusting, and collection of data.

The data represent only one season's results, but due to the fact that little information is available on the powdery mildew of the pea and as some of the results obtained are outstanding, it seemed advisable to publish the results at this time. The experiment will be continued during the season of 1927 and other features added.

ECONOMIC IMPORTANCE OF POWDERY MILDEW.

This mildew of peas has been known for many years and is of wide distribution. As a rule, it is not of great economic importance, but occasionally causes much damage.

The seriousness of powdery mildew is greatly influenced by climatic conditions; its spread is often quite rapid during a rainy season. The disease attacks not only the foliage and stems, but also the pods; producing a disfigured, russeted appearance that greatly detracts from the market value. If the pods are badly mildewed they are refused by the packing companies. When the mildew attacks young plants the crop is generally a total loss.

DESCRIPTION OF THE DISEASE.

Powdery mildew of peas is caused by a fungous parasite, *Erysiphe polygoni* D. C. The fungus never penetrates the tissue of the pea plant but extends its growth over the surface of the parts attacked, simply sending into the epidermal cells little suckers through which it draws its nourishment. The plant body of the mildew is fully exposed to any direct applications which may be made to destroy it.

Fig. 1.—Showing peas from first planting. The peas in the plot at the right were grown from seed that had been given the hot water treatment; those in the center plot, from untreated seed; those in left-hand plot, from seed that had been given the bichloride treatment. Note the difference in stand and size of plants.

During the summer many spores are formed and it is the mass of spores which gives the white powdery appearance. This mildew produces two very unlike sets of reproductive bodies or spores. During the early part of the season, the mycelial threads send up short erect branches which bear the summer spores or conidia. The spores thus produced are very numerous, and as they are ready to germinate as soon as they have fallen from their support, the spread of the fungus during the summer is often very rapid. Later in the season, the second form of spores is produced. They seem to a certain extent to carry the fungus over winter, and therefore are called winter spores. These winter spores are formed in little sacs which are enveloped in a hard, globular covering from which radiate a number of delicate appendages. When mature, the globular body (termed perithecium) is black and sufficiently large to be seen with the naked eye. In New Mexico these perithecia are produced in abundance by the middle of August, and appear on the mildewed surface as minute black specks.

The mildewed appearance of the leaves, stems, and pods, all of which appear whitened as though dusted with flour, is characteristic. The first appearance of the disease is usually manifested in small grayish or whitish felt-like patches of mycelium on the lower leaves. These patches rapidly enlarge, and generally the entire leaf becomes covered with the mycelium and a powdery coating of spores. Infected leaves eventually become brittle and die but seldom fall from the plant.

The leaves and growing parts are robbed of food, and their growth is checked. The pea vines become dwarfed, the tissues of the leaf become dry and brittle, and if infection is severe, the plants may die.

OBJECTS OF THE EXPERIMENT.

The objects of this experiment were: first, to find if the mildew could be controlled by seed treatment; second, to determine how the disease might be controlled in the field; and third, to find proper dates for planting. Data were also secured on length of time from planting to blossoming, flat and full pod.

SEED TREATMENT.

It has been mentioned by several investigators that the powdery mildew of the pea is carried from one season to another in and on the seed.

Van Hook (1) states that the mildew fungus lives over winter on the seed and that pea seed apparently free from fungus when put into the germinator, soon develops a covering of mold in which hundreds of the fruit bodies (perithecia) are formed.

Stevens (2) states that the fungus hibernates in seed derived from affected pods and that such seed should not be used for planting.

The author of this bulletin (3) found, from experiments conducted in the laboratory with pea seed from mildewed vines, that the disease lives from one season to another on and in the seed.

Through the kindness of Mr. L. F. Jones, Extension Agent for San Miguel County, New Mexico, the author secured a quantity of pea seed from mildewed vines. This seed was light, of poor quality, and gave a germination of 57.5 per cent.

After being treated in various ways the seed was placed in petri dishes containing potato agar. At the end of four days the dishes were examined and the presence or absence of mildew on the seed noted. The following table gives the results:—

TABLE I.—EFFECT OF SEED TREATMENT ON MILDEW.

Treatment	Number of seeds plated	Seeds mildewed
		Per cent
Untreated	500	22.5
Hot water, 56° Centigrade, 20 minutes	500	1.5
Hot water, 60° Centigrade, 20 minutes	500	0.0
Bichloride of mercury, 1-1,000, for 20 minutes	500	12.5

The temperature of 60° Centigrade, or 140° Fahrenheit, for 20 minutes killed all the fungus on and in the seed, but reduced germination decidedly. It is apparent from the above table that powdery mildew is carried internally as well as on the exterior of the pea seed. The disease can be reduced to a minimum by treating the seed with hot water at 56° Centigrade (133° Fahrenheit) for 20 minutes.

The pea seed must be treated in small lots in order that all of it may quickly and uniformly reach the desired temperature. Two tubs or vats of water should be used. In one tub the exact temperature required should be maintained, while the other (Tub 1) is used only in bringing the seed to the temperature of the treatment, so as not to lower the temperature in Tub 2. The seed should be placed in small loose sacks and plunged into Tub 1 for a short time, then transferred to Tub 2 and kept immersed for twenty minutes at a temperature of 56° Centigrade. The action of the heat should be terminated as quickly as possible, and a cold dip is advisable,

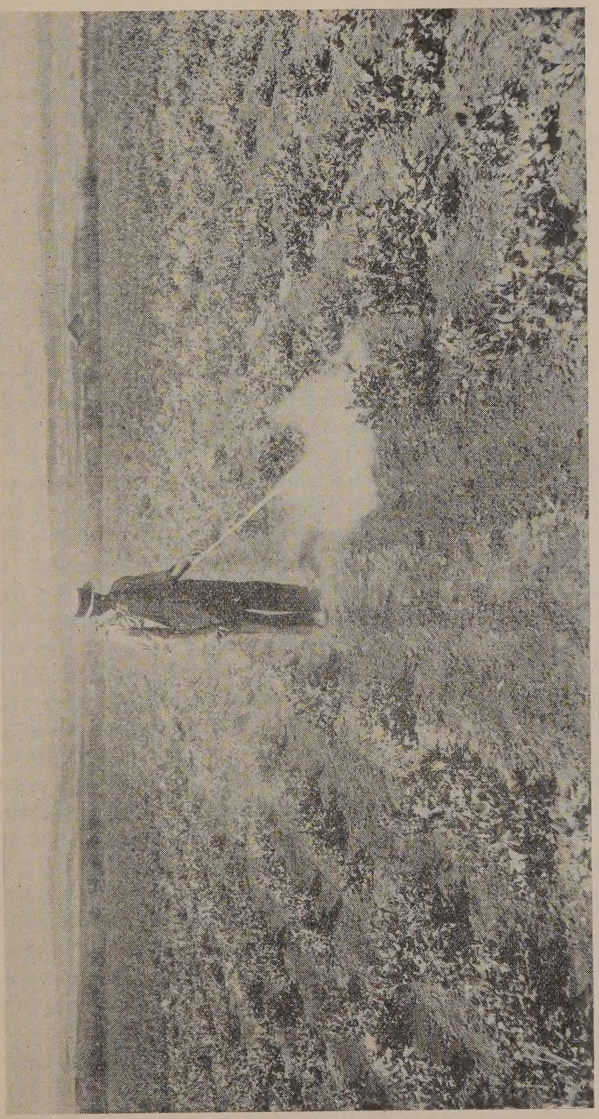

Fig. 2.—Dusting peas for powdery mildew.

applied immediately after the seed has been heated the required length of time. A reliable thermometer is necessary, since inaccurate instruments may result in injury to the germinating power of the peas or in the failure to prevent the mildew. The seed may be dried by spreading out in thin layers, on a clean granary floor or on canvas. It should not be allowed to sprout. Seed treated as indicated may be planted as soon as it is sufficiently dry to run freely through the drills.

PREPARATION OF THE PLOT.

A five-acre plot of ground was selected on the Storrie Project at Las Vegas, New Mexico, and divided into four equal subplots. These four subplots were planted to peas on the following dates: June 19, July 4, July 14, and July 20, 1926. Each subplot was further divided into three equal parts and planted to Dwarf Telephone peas that had been treated with hot water at 56° Centigrade for 20 minutes; seed soaked in bichloride of mercury, 1 to 1,000, for 20 minutes; and untreated seed. Each planting consisted of sixty-six rows of peas, 320 feet long and 28 inches apart, or twenty-two rows of each of the three seed treatments.

First Planting.—The ground had not been irrigated before planting and was slightly lumpy. The seed was planted at the rate of fifty pounds to the acre, two inches deep, with a two-row corn planter. There was not enough moisture in the soil for it to germinate, so the plot was given the first irrigation on June 27, 1926. Subsequent irrigations were given on the following dates: August 13, September 5, and September 13. The plot was cultivated on July 4, July 9, July 15, July 22, July 29, August 6, and August 18.

A fair stand was obtained on all three plots but the untreated seed was much slower to germinate and the plants seemed less thrifty. At three weeks from planting, plants from untreated seed were but half the size of those in the other two plots (Figure 1). The stand from the untreated seed was not as good as from either the hot water, which was the best, or the bichloride treated seed. This difference in stand and thriftiness of the plants produced from treated and untreated seed was very noticeable in all four plantings.

On July 9, 1926, V. A. Bishop, Field Assistant at the experimental plot, wrote as follows:—

"Something has developed in connection with the first planting that I do not understand and I am wondering if you can explain it.

"The first section of twenty-two rows near the road was planted with bichloride treated seed. There is less than two-thirds of a full stand and some of the plants are none too thrifty.

"The second section of twenty-two rows was planted with untreated seed. There is less than half a stand of these and they are not very thrifty.

"The third section of twenty-two rows was planted with the hot water treated seed; with these there is an excellent stand. The plants are thrifty and growing fine."

Second Planting.—The ground was disked, harrowed, and floated on June 23, 1926. The first irrigation was given on June 27. The ground was again disked, harrowed, and floated and the seed planted on July 4. Seed was planted two and one-half inches deep with a two-row Blackhawk Chief corn planter. The seed germinated much more quickly than that of the first planting. This was because the ground was in better physical condition and contained sufficient moisture for germination. The first cultivation was given July 15 and subsequent cultivations on July 22, July 29, August 6, August 18, and August 26. Further irrigations were given on September 5 and September 13.

The first plants made their appearance eight days after planting. The seed treated with hot water germinated quicker and produced a decidedly better stand of peas than either the bichloride treated or the untreated seed. The plants were also considerably larger and more thrifty in the hot water treated plot.

Third Planting.—The ground was disked, harrowed, and floated on July 5 and irrigated on July 6. The seed would have been planted on July 11 but for a heavy rain on that day. The ground was again disked and floated on July 14; the planting being done the same day. The seed was planted at the rate of 50 pounds to the acre, two and one-half inches deep, with a two-row International corn planter. On the night of July 22 a heavy rain occurred that beat many of the plants into the ground, a great deal of damage being done. About half a stand of peas was showing at this time. When the ground dried a crust formed that kept many plants from coming through. These adverse conditions resulted in a poor stand. The plot was irrigated on August 13 and September 5, 1926, and cultivated July 22, July 29, August 6, August 18, and August 25. On account of disking after irrigation and before planting, the weeds were not nearly so numerous as they were in the first planting, where the seeding was done in dry soil and the peas irrigated up.

Fourth Planting.—The plot was irrigated on July 10, disked, floated on July 17, and planted to peas July 20. The seeding was done at the same rate as in the other plantings, with a John Deere two-row corn planter.

On the night of July 22 a heavy rain washed out, or covered too deeply, much of the seed in a strip running diagonally through the center of the plot. The hot water and check plots suffered the most. On parts of this planting not affected as above, an excellent stand was secured with the hot water treated seed. Later cultivations and irrigations were the same as for the third planting.

DUSTING EXPERIMENTS.

Each planting was divided the narrow way into four equal parts; the first part to be dusted with four parts sulfur to six of hydrated lime before the mildew appeared, or about the time of the flat pods; the second to be dusted with the same mixture after the mildew appeared; the third to receive no treatment; and the fourth to be dusted with pure sulfur.

Fig. 3.—Pickers at work in the plots.

Dust was applied to the first part of the first planting on August 21. On the afternoon of August 21 a rain washed off the dust applied in the morning. On August 24 more dust was applied on rows 1, 2, 3, and 4 of each of the seed treatments. The plants receiving the later dustings showed no benefit over those receiving the one dusting and that washed off the same day. No mildew developed on this part during the entire season, nor was it given another dusting. A number of plants in the untreated plot were found attacked by mildew on August 25, three in the bichloride, and none in the hot water treated.

The second and fourth parts were dusted with their respective mixtures on August 25. Both of these treatments stopped the mildew at once. Pure sulfur is difficult to apply, as it clogs the duster.

The plot was visited by the author on October 8 and the following data recorded: None of the plots dusted with four parts sulfur to six of hydrated lime before the mildew appeared, showed signs of the disease. The plots dusted with the above mixture after the mildew appeared had an occasional plant attacked. The bichloride treated plots that had received no dust had approximately ten per cent mildew. The hot water treated plots receiving no dust had a trace of mildew. The untreated seed plots that received no dust showed one hundred per cent mildew. The plots receiving pure sulfur as a dust showed an occasional plant attacked.

None of the seed treatments entirely controlled the mildew, but the hot water treatment reduced it considerably and delayed its appearance. It is entirely possible that the mildew could have been spread from the untreated to the hot water treated plot.

The experiment proved that mildew can be controlled in the field by dusting with sulfur at the rate of four parts sulfur to six of hydrated lime. The best time to apply the dust seems to be before the mildew appears, or about the time of the flat pods. There is no apparent advantage secured by the use of pure sulfur as a dust.

The dust was applied at the rate of fifty-six pounds to the acre, at a cost of $1.70 for materials. Labor in applying the dust was estimated at 30 cents, making the total cost of dusting $2.00 an acre.

YIELDS.

A heavy frost occurred on October 5, which made it impossible to obtain total yields of any except the first planting. The pods were injured by the frost and the packing companies refused to accept them.

Only a few pounds of peas were obtained from the plots planted on July 14 and July 20. These dates are apparently too late to plant peas with safety in the vicinity of Las Vegas, New Mexico.

The plot planted on July 4 produced, up to October 5, 3,367 pounds of peas. Parts of the plot were unpicked, so the yield is not complete. This planting would have produced a larger yield than the first.

The yields from the first planting are given in Table II.

TABLE II.—YIELDS OF PEAS FROM FIRST PLANTING.

Dust treatment of plots*	Untreated	Seed treatment	
		Bichloride	Hot water
	Pounds	Pounds	Pounds
Four parts sulfur to six of hydrated lime before mildew appeared	248	329	385
Above mixture applied after mildew appeared	277	324	399
No dust treatment	204	288	305
Pure sulfur	153	196	288
Total yield	882	1137	1377

*Each plot contained one-tenth acre.

It will be noted from the above table that both the bichloride and hot water treated plots that received no dust produced more pounds of peas than the untreated plot that was not dusted. A large percentage of the pods from the untreated plot was not marketable, on account of being russeted by mildew. The yield from the hot water treated plot in all cases exceeded that of the bichloride. There is no plausible explanation for the decreased yields of the plots dusted with pure sulfur.

PHENOLOGICAL DATA.

A representative showing of blossoms in the first planting occurred August 1 to 5, or forty-four to forty-eight days after planting. A representative showing of flat pods was recorded on August 15 and the peas were ready to pick on August 30. This makes a total of seventy days from planting to picking time.

An average taken from the various plantings gives the length of time from planting to blossoming as fifty-one days, from blossoming to flat pod as thirteen days, and from flat pod to ready to pick as thirteen days.

ACKNOWLEDGMENTS.

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SUMMARY.

Powdery mildew of peas is usually the limiting factor in the successful production of this crop in the mountainous sections of New Mexico.

The disease lives from one season to another on and in the pea seed.

Powdery mildew can be reduced to a minimum by treating the seed with hot water at 56° Centigrade (133° Fahrenheit) for 20 minutes.

Dusting the plants with a mixture consisting of four parts sulfur to six of hydrated lime will control the disease in the field. The best time to apply the dust appears to be before the mildew appears, or about the time of flat pods.

Increased yields can be obtained by treating the seed with hot water and dusting the plants with the sulfur-lime mixture.

On account of frosts, peas should not be planted after July 10, in the vicinity of Las Vegas, New Mexico. The average length of time from planting to mature pods that are ready to market is approximately seventy days.

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